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(54) Restrained and flame-retardant laying of electric cables

(57) One or more electric cables C are laid in a tunnel G or other channel by forming a ductway comprised of non flammable elongate U-shaped supports S1, S2, S3 individually anchored to a support floor PG with gaps I1, I2, I3 between them which gaps are sealed by flexible and nonflammable means, then laying the cables and securing their opposite ends ST1, ST2 and filling the ductway with particulate material such as sand to inhibit the cables against longitudinal movement. The supports are then closed by nonflammable slabs P1, P2, P3 and the gaps between them sealed by flexible nonflammable means.

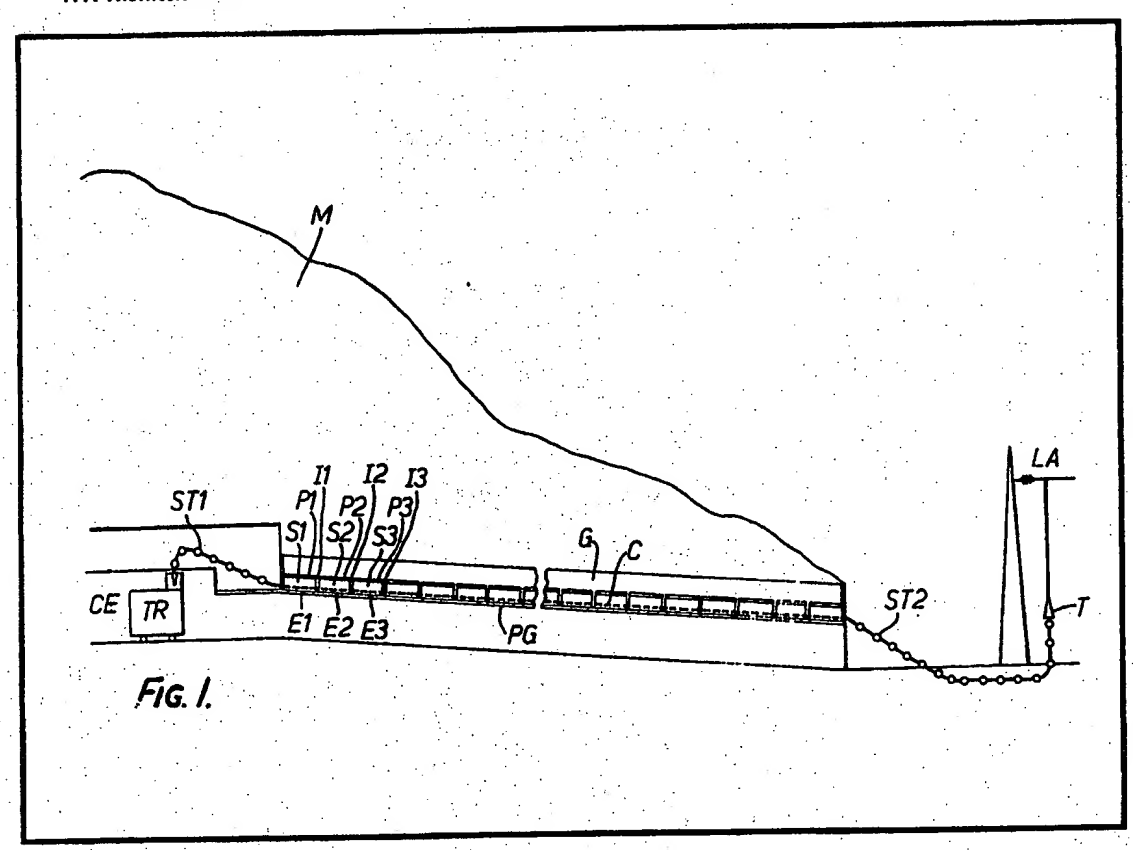

FIG. 1.

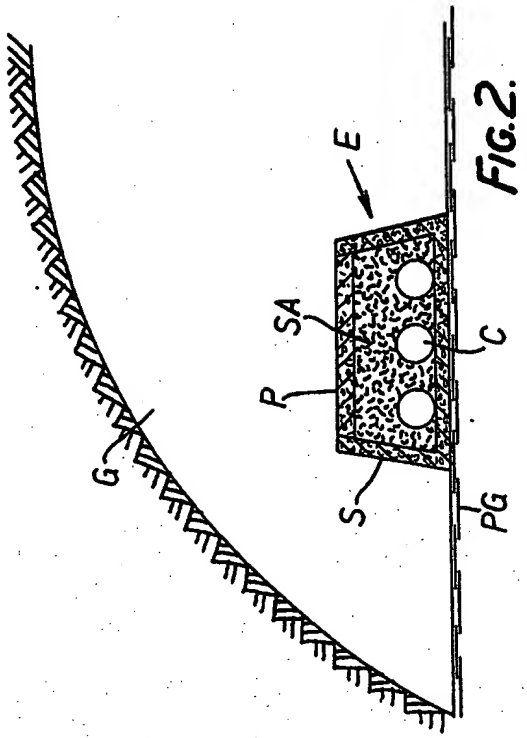
E
SA
C
P
S
PG
G

FIG.2.

LA
T
ST2
C
G
PG
I3
P3
S3
I2
P2
S2
I1
P1
S1
E3
E2
E1
M
ST1
TR
CE

FIG. 1.

SPECIFICATION

Restrained and flame-retardant laying or electric cables

The present invention relates to a system of laying an electric cable such that it is protected against flames and is restrained against movement.

More particularly, the present invention relates to a system in which the protection against flames is obtained by disposing the cables within a ductway of rigid and nonflammable material and the restraint against movement is obtained by anchoring the ductway to a flat bottom and filling the ductway with sand or like material.

As is known to technicians in the art, retraining the cable inhibits it from any variation in length owing to thermal variations.

A case in which a laying system in accordance with the present invention finds a particularly advantageous application is that relating to the laying of power cable for transmitting power at voltages of the order of 200–400 kV inside a tunnel (which can extend for several hundred metres) for the connection of an output transformer of a hydroelectric generating-station, disposed in an underground cavern, with a sealing end providing a commencement of an overhead line.

For this reason, in the following description the main reference will be made to such case; however, it will be apparent that the laying system according to the present invention can find an advantageous application in all cases where a restrained and/or flame-retardant laying is required.

It is known that one of the main problems in the arrangement of electric cables passing through narrow and long channels (underground passages, tunnels and so on) is that of preventing fires or the diffusion within the channel of fire flames originating somewhere else. Flames developing within these channels can in fact be faced only with difficulty and therefore could rapidly destroy the plants.

In order to avoid this risk, the cables can be dispoed within suitable elongate containers of non-flammable material. However, in the case of power cables, the presence of the container makes very difficult the laying of the cables themselves, involving the application of clamping means secured to fixed structures (according to the known techniques of restrained laying or of waved laying): on the other hand, the rstrained or waved laying operation is essential for power cables, in consequence of great thermal variations produced by variations in the transmitted power.

As in this situation the cable cannot be clamped it is possible to apply another known technique for the restrained laying, consisting in arranging compressed layers of sandy materials around the cable; this latter technique can be applied to the particular case in question, i.e. to the case in which the cables are laid in a container having fire-protective functions, on condition that the container has sufficiently rigid and strong walls and is anchored to the ground.

In the practice, the following solution is therefore adopted. A fixed structure constituted by a duct-way of concrete having generally a U-shaped cross section is formed along the tunnel. This ductway is generally secured in place by effecting a concrete casting either in a trench excavated in the floor of the tunnel or on the floor itself; anyhow, the ductway thus formed is anchored to the ground, at least by means of its own weight and of the weight of the materials eventually contained therein. The electric cables are laid on the bottom of the ductway; the ends of the cables projecting from the ends of the ductway are secured to fixed supports by clamping means; the ductway is filled with sandy materials according to known techniques; and then the ductway is completed by placing a concrete covering over its top. This covering can be provided either by means of a concrete in-situ casting or by applying pre-fabricated slabs.

Of course, the open ductway can be formed, instead of by a single concrete in-situ casting, by placing on the channel bottom a plurality of pre-fabricated elements. However, hitherto said elements have been placed in contact the one with the other and rigidly jointed to one another; therefore in this case also the ductway comprises effectively a single rigid formation anchored to the channel bottom.

By operating according to the above known techniques a rather satisfactory restrained and nonflammable laying is obtained. On the one hand the ductway is anchored to the floor of the tunnel or other channel and therefore it should not suffer elongations, and on the other hand the sand exerts on the walls of the cables such frictional forces as to inhibit variations in length of the cables themselves. Moreover, the ductway and the sand clearly provide valid protection against flames.

However, the above laying system has a drawback which must not be disregarded. As it is easily understandable, the ductway is in practice subjected to mechanical stresses generated both inside and outside of the ductway. The inner stresses are caused by longitudinal forces developing in the cables owing to the variations in working temperatures; the outer stresses are caused by the settling of the bearing surfaces of the ductway (the floor of the tunnel or other channel). These latter stresses are quite unforseeable, both in respect of their application zone, and in respect of their entity and their effects, and therefore it is not easy to take these forces into account in planning and realising the ductway. Anyhow, both the stresses generated inside and

the forces generated outside of the ductway tend to concentrate their action in particular points of the ductway (as for example, in zones where there is a rigid connection).

It follows that the ductway itself can undergo, in greater or lesser time periods, deformations, cracks and failures, with consequent serious danger for the cables contained therein and for the safety of the whole electrical system.

In accordance with the present invention, there is provided a system of restrained and flame-retardant laying of one or more electric cables, comprising a duct-way of rigid and nonflammable material in which said electric cable or cables is or are disposed, said ductway being anchored to a floor on which it is supported and filled with particulate material, said ductway being formed by a plurality of elongate elements, separated from one another by a gap and individually anchored to said floor, and by flexible and nonflammable means sealing the gaps.

Also in accordance with the present invention there is provided a method of restrained and flame-retardant laying of one or more electric cables, comprising the steps of: (a) disposing on a supporting floor a plurality of supports having a generally U-shaped cross section, said supports being individually anchored to said floor and the supports being aligned with each other but separated by gaps; (b) sealing said gaps with flexible and nonflammable means, thus to form a ductway; (c) laying within said ductway one or more electric cables and anchoring the opposite ends of said cables to fixed structures by clamping means; (d) filling said ductway with particulate material; (e) applying and securing in place a slab of rigid and nonflammable material on each one of said supports, each of said slabs closing the top of its support but with a gap being left between adjacent slabs; and (f) sealing said gaps between slabs by flexible and nonflammable means.

An embodiment of the present invention will now be described, by way of example only with reference to the accompanying schematic drawings, in which:

Figure 1 is a section along a cable path through a tunnel extending from output transformers of a hydroelectric generating-station placed in an underground cavern and sealing ends from which overhead lines commence; and

Figure 2 is a cross section through the tunnel of Fig. 1.

Fig. 1 shows a cable C (but, of course a plurality of cables may be provided) in a length of electric line between the transformers TR of a generating-station CE and the sealing ends T, from which overhead lines LA commence. This electric line pases through a tunnel G formed in a mountainous relief M.

On the floor PG of the tunnel G (in practice a flat floor) there are provided elongate elements E1, E2, E3 etc. separated from one another by gaps I1, I2, I3 etc. Each of the elongate elements comprises a support S1, S2, S3, etc. having a generally U-shaped cross section and a closure slab P1, P2, P3 etc; each slab covers completely the top of its support and is secured to the latter. Both the support and its closure slab are formed of a rigid and non-flammable material; in the example shown this is preferably concrete.

The elongate elements E1, E2, E3, etc. must be appropriately anchored to the tunnel floor; in the case in which they are of concrete, their own weight and the weight of the materials contained therein constitute a sufficient anchoring means.

The elongate elements E1, E2, E3 etc are aligned with one another and separated by gaps I1, I2, I3 etc., which are small compared with the length of each elongate element. Overall, the elongate elements form a ductway having interruptions or gaps between adjacent elongate elements.

The cable C is laid in the ductway thus provided: the cable ends projecting from the ductway ends are secured and anchored to fixed structures by clamping means ST1 and ST2.

The ductway is filled with sand or like inert particulate material according to known techniques, and the gaps are sealed over their outer perimeters by flexible and nonflammable means; preferably, in this example, silicone mastics or gummed tape, both loaded with appropriate quantities of flame-retardant additives.

The sequence of operations for laying the cable or cables is as follows: firstly, to arrange and to anchor to the tunnel floor the supports of generally U-shaped cross section such that they are aligned to one another and separated by gaps (said supports can be formed in-situ or pre-fabricated and thereafter placed into the tunnel); to seal the gaps between said supports; to lay the cable and to clamp its ends; to cover the cable with the sandy materials; to place and to secure the slabs on the respective supports; and then to seal the gaps between contiguous slabs.

Fig. 2 shows an elongate element E, which in the preferred embodiments has the cross-section of an isosceles trapezium. This element comprises a support S having a flat base and two sides inclined towards each other in the upwards direction, and a slab P applied to the inner sides of the free ends of said sides of the support S. In the case in which the support and its slab P are of concrete, the application of the slab can be made by an in-situ concrete casting.

The elongate element ductway houses three cables C and is filled with sandy materials SA. These materials provide for eventual settling of the elongate elements E without involving

the cables.

The characteristics of the individual elongate elements (material, length, thickness of the walls etc) and of the ductway (distance between contiguous elongate elements, nature of the flexible and nonflammable means, etc) can change according to the characteristics of the cables (dimensions, powers transmitted, coefficient of expansion, etc) and of the zone or environment through which the cables are to be laid.

For example, in the case in which said elongate elements are of concrete and for cables intended to carry 200–400 kV, it is convenient that each elongate element has a length of about 1 meter for cables provided with an aluminium protective sheath and of about 0.5 meter for cables provided with a lead protective sheath; the gap between contiguous elongate elements is about 1 cm.

From the above, it is apparent that the advantages of the system illustrated derive from the use, instead of a ductway constituted by a single rigid block anchored to the bottom, of a ductway constituted by a plurality of rigid and nonflammable elements spaced from one another, individually anchored to the bottom and therefore independent from one another.

The gaps provided between contiguous elongate element permit in fact small movements or deformations of each elongate element, without causing damage to the overall ductway. On the other hand, the flexible and nonflammable means, sealing along the outer perimeters of the gaps provided between contiguous elongate elements, have the function of preventing the escape of sandy materials and of avoiding leaving lengths uncovered and therefore open to flames; this is not prejudicial to the independence of each elongate element with respect to its neighbouring elongate elements.

The system therefore enables the cables to be laid in such a way as to satisfy the required conditions of rigidity and nonflammability and without the risk that the mechanical stresses generated inside and outside of the ductway concentrate at particular points of the duct-way itself, with serious damage for the ductway and for the cables. The sectionising of the ductway into a plurality of elements provides for considerable ease in the preparation of the ductway itself.

CLAIMS

1. A system of restrained and flame-retardant laying of one or more electric cables, comprising a duct-way of rigid and nonflammable material in which said electric cable or cables is or are disposed, said ductway being anchored to a floor on which it is supported and filled with particulate material, said ductway being formed by a plurality of elongate elements, separated from one another by a gap and individually anchored to said floor, and by flexible and nonflammable means sealing the gaps.

2. A system according to claim 1, in which each of said elongate elements comprises a support having a generally U-shaped cross-section and a closure slab secured to and closing the top of said support.

3. A system according to claim 2, in which each said support has a flat base and two sides inclined towards each other in the upwards direction.

4. A system according to any preceding claim, in which said flexible and nonflammable sealing means comprises silicone mastic loaded with a flame-retardant additive.

5. A system according to any one of claims 1 to 3, in which said flexible and nonflammable sealing means comprises adhesive tapes of a material loaded with a flame-retardant additive.

6. A method of restrained and flame-retardane laying of one or more electric cables, comprising the steps of: (a) disposing on a supporting floor a plurality of supports having a generally U-shaped cross section, said supports being individually anchored to said floor and the supports being aligned with each other but separated by gaps; (b) sealing said gaps with flexible and nonflammable means, thus to form a ductway; (c) laying within said ductway one or more electric cables and anchoring the opposite ends of said cables to fixed strutures by clamping means; (d) filling said ductway with particulate material; (e) applying and securing in place a slab of rigid and non-flammable material on each one of said supports, each of said slabs closing the top of its support but with a gap being left between adjacent slabs; and (f) sealing said gaps between slabs by flexible and nonflammable means.

7. A method according to claim 6, in which each slab is applied by means of an in-situ concrete casting.

8. A system of restrained and flame-retardant laying of one or more electric cables, substantially as herein described with reference to the accompanying drawings.

9. A method of restrained and flame-retardant laying of one or more electric cables, said method being as claimed in claim 6 and substantially as herein described with reference to the accompanying drawings.

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